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Taxation and Migration: Policies to Manage a Resource Boom

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Abstract

The Australian economy is currently experiencing a resource boom and policy responses to this boom such as migration and taxation, as well as the broader role of monetary and fiscal policies are the subject of academic as well as public debate. This paper investigates the impact of a resource boom in a dynamic macroeconomic model, focusing on the allocation of resources across sectors and changes in income distribution. Further, the paper contributes to the current policy debate by analysing the role and effectiveness of government policy through its migration policy and taxation of the mining sector, in addressing the short run and steady state impacts of a resource boom. Results illustrate that while increased immigration is an appropriate short run response, long run welfare can be enhanced by higher taxation of the mining sector. Indeed, results show that increased tax revenue can fund appropriate transfers to mitigate the adverse effects on labour income and provision of public goods to increase productivity in the rest of the economy.

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Keywords: Dutch Disease, natural resources, economic growth, income distribution

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1. Introduction

The current state of the Australian mining boom and its distributional impacts has attracted a lot of attention from policymakers, with response ranging across taxation, migration and labour market policies. While the possible adverse impacts of a resource boom are well documented in the empirical and theoretical literature, the policy response to address the distributional and welfare impacts of such a resource boom has been a subject of little analysis. The present paper analyses the effect of this booming sector on income and resource distribution in the economy and on welfare using a dynamic macro model. We then explore the policy alternatives to deal with these distributional issues. In the context of the current debate about the appropriate policy settings, we demonstrate how the adverse effects of “Dutch Disease” can be addressed through a combination of taxation and labour policies with productivity-enhancing public spending.

Empirical studies have now established that resource booms may not have a beneficial effect on the economy and may even be detrimental to economic growth (Sachs and Warner, 2001; Ploeg, 2011). The theoretical basis for so-called Dutch Disease suggests that an economy with a booming resource export-oriented sector is affected through two channels: First, it leads to an appreciation of the domestic currency and, as a result, harms other non-resource exporters. Second, a resources boom leads to a reallocation of factors of production such as labour and capital away from other sectors to the booming sector.¹

These basic features of Dutch Disease have been highlighted by Gregory (1976) and Corden

¹ In addition to these two channels, Anderson (1998) comprehensively discusses the role of (i) declining terms of trade (the ‘Prebisch-Singer’ hypothesis), (ii) externalities in non-resource sectors, (iii) technological catch-up, (iv) protectionist barriers and (v) distortions at home.

and Neary (1982). The present paper is part of a recent research effort to understand the distributional effects of the boom and the role of government policy. Cassing and Warr (1985) focus attention on income distribution during a resource boom, pointing out that it is the changes in real factor incomes, rather than industry sizes, that determine the distribution of gains and losses. Fum and Holder (2010) find that the effect of a resource boom depends on the ethnic composition of the society. The role of the government in meeting the challenges of a resource boom has increasingly come into focus, with recent research focusing on the political economy of the effects of resource boom and rents on the political state (Auty, 2010), and on fiscal policy rules in managing a resource boom (Ploeg, 2011).

Frankel (2010) surveys the institutions and policies employed by the governments with varying degrees of success in managing the resource booms. Taxation of the export commodities has been used in some developing countries, particularly if the producers are foreign-owned companies. Countries such as Chile have tight rules governing the fiscal policy to make national saving procyclical, while Norway is an example of successful use of a sovereign wealth fund to achieve similar objectives. In addition, Alaska uses the fund to address distributional issues of the resource boom.

While Australia has previously experienced mining booms (see Battelino, 2010, for an overview of mining booms in Australia), the current boom is notable due to (i) the extent and persistence of increase in terms of trade, and (ii) the timing. Currently, the terms of trade are the highest on record and indications are that they will remain high for longer

than the previous episodes of mining booms. This boom is also occurring in the context of an economy operating at close to full capacity, and is the first boom since Australia abandoned the relatively fixed exchange rate regime. Impacts of the mining boom are already showing up in the economy. An increase in mining output creates imbalances, with the share of output of sectors such as manufacturing declining (Figure 1). Demand for mining commodities has led to an increase in current and future planned production which, in turn, is taking the investment in this sector to historically high levels (4 percent of GDP compared to an average of 2 percent (Stevens, 2011)). While mining is a relatively capital intensive sector that accounts for a small proportion (1.8 percent) of total employment, Figure 2 illustrates the dramatic growth in the labour employed in this sector. This demand for labour puts pressure on wages and employment in other sectors of the economy. Indeed, the challenge of meeting this increased labour demand in the mining sector has led the government to moderate its earlier decision of cutting immigration intakes and to allocate an increased number of immigrant workers in the recent 2011 budget.

In order to meet the challenges of the mining boom and to address the imbalances in the economy, the Australian government in 2010 proposed a higher tax on the mining sector (the Minerals Resource Rent Tax). The design of this policy has been vigorously debated in terms of taxing of economic rents (e.g., see Ergas et al., 2010, and Freebairn and Quiggin, 2010). The present paper provides another perspective on the debate by exploring the effects of such taxation policy in addressing the allocation problems, as well as addressing the short and steady state welfare changes created by the mining boom.

The challenge for the policymakers is to manage the adverse impacts of the resource boom. While monetary policy can target inflation resulting from demand pressures in the resource sector, it cannot fundamentally address the underlying allocation of factors of production and income distribution. In fact, a higher interest rate worsens the pressure on the rest of an economy that is already squeezed by the resource boom. Thus, the role of government through its labour market policies, public good provision, and taxation and redistribution policies, becomes crucial in times of resource booms. However, with the exception of an analysis of its role in the tourism sector (Chang et al., 2011), this role of government has not been analysed in the context of macroeconomic models. We address this gap in the literature by (i) analysing first the short run and steady state impacts of the resource boom in a dynamic macroeconomic model, the results focussing on allocation of labour and capital across sectors and on income distribution in the economy, and (ii) investigating the policy options for the government to address the adverse effects of a resource boom.

Section 2 develops a dynamic macroeconomic model for an economy experiencing a resource boom. The results show that a mining boom will lead to a decline in manufacturing output, shift the income distribution in favour of capital, and can lead to a welfare loss in the long run. Immigration and taxation policy settings and role of the government in addressing efficiency and equity challenges posed by the short run and long run effects of a mining boom are analysed in Section 3, while Section 4 sums up the main findings and conclusions.

2. *The model*

Let us consider a model economy with two sectors: non-mining (manufacturing) and mining. We assume that the non-mining good, X , is generally consumed domestically, although it can be traded internationally, while the mining output (Y) is produced only for exports.

There are three types of agents in the economy: firms, households, and government. The external sector is given exogenously. Trade is always balanced. In order to focus on domestic resource allocation, we abstract from capital flows. In general, a resource boom results in an increase in returns to capital, hence, capital inflows and possible over-borrowing (e.g. Cassing and Warr, 1985; Kuralbayeva and Vines, 2008). Under the assumption that trade and financial accounts should be balanced in the long run, we can abstract from financial borrowing in our analysis. Moreover, capital mobility will not eliminate the distortion created by a mining boom in factor allocation between sectors as long as the levels of capital-intensity vary between sectors. Since our main focus is on the effect of a mining boom on this allocation of factors of production in the economy, we can abstract from the external side of the economic activities.

Firms produce goods and maximize after-tax profits taking the inputs prices given. Households maximize their intertemporal utility by consuming good and services (X) subject to their budget constraint. In addition, households hold assets in the form of ownership of claims on capital used by firms. Government taxes firms and spends the revenue as transfers to households and to provide productive inputs to firms. We abstract

from income taxes in order to concentrate on the effects of differential taxation for the two sectors in the economy. It is also assumed that the government budget is always balanced.

2.1. The supply side

The two sectors in the economy, mining and manufacturing, are perfectly competitive and use both capital and labour in production. Firms produce goods and pay wages and rental payments. We take the non-mining good X as a numeraire; hence, the relative price of the output of the mining sector Y is defined as P . Given the context of Australia as a small open economy, we assume that the price for mining output is determined by the international markets and, hence, is exogenous for the economy. The government taxes firms' output at the rate τ_x for manufacturing firms and rate τ_y for mining firms.

Manufacturing sector

Firms in the manufacturing sector employ a Cobb-Douglas technology to produce good X :

$$X = AK_x^\alpha L_x^{1-\alpha}, \quad 0 < \alpha < 1, \quad (1)$$

where technology coefficient, A , is a function of the productive government services, g , such that $A(g)$, $A'(g) > 0$, $A''(g) < 0$. K_x and L_x , respectively stand for capital and labour employed in the production of X . Parameter α is the share of capital.

Given the production function, the representative firm in the manufacturing sector maximizes after-tax profits, Π_x , as the following optimization problem:

$$\max_{K_x, L_x} \Pi_x = (1 - \tau_x)X - wL_x - rK_x, \quad (2)$$

where r is the rental rate of capital and w is the wage rate. For simplicity, we assume that the depreciation rate of capital is zero. The first-order conditions yield the following equilibrium rate of return to capital:

$$r = \frac{\alpha(1 - \tau_x)X}{K_x}, \quad (3)$$

and the wage rate:

$$w = \frac{(1 - \alpha)(1 - \tau_x)X}{L_x}. \quad (4)$$

Mining sector

A representative firm in the mining sector employs a Cobb-Douglas technology and produces mining output:

$$Y = BK_y^\beta L_y^{1-\beta}, \quad 0 < \beta < 1, \quad (5)$$

where B is a constant technology coefficient, and K_y and L_y stand for capital and labour employed in the production of Y , respectively. Parameter β denotes the share of capital.

The mining sector is assumed to be more capital intensive than manufacturing, $\beta > \alpha$.

Further, note that productivity in the manufacturing sector depends on the provision of government services, while productivity in the mining sector is assumed to be independent.

This reflects the fact that the location and operation of most manufacturing firms are influenced by the availability of public infrastructure.

A representative firm in the mining sector maximizes after-tax profits, Π_y , given the production function:

$$\max_{K_y, L_y} \Pi_y = (1 - \tau_y)PY - wL_y - rK_y, \quad (6)$$

where r is the rental rate of the physical capital and w is the wage rate. These rental rates are derived by solving first-order conditions:

$$r = \frac{\beta(1 - \tau_y)PY}{K_y}, \quad (7)$$

and:

$$w = \frac{(1 - \beta)(1 - \tau_y)PY}{L_y}. \quad (8)$$

Factor markets

Since all sectors operate under perfect competition, after tax profits will be zero. Total labour force L is divided between manufacturing and mining sectors:

$$L(t) = L_x(t) + L_y(t) \quad (9)$$

That is:

$$\frac{L_x(t)}{L(t)} + \frac{L_y(t)}{L(t)} \equiv l_x + l_y \equiv 1. \quad (10)$$

Similarly, total capital is a sum of capital employed in manufacturing and mining:

$$K(t) = K_x(t) + K_y(t). \quad (11)$$

In terms of fractions of the total capital stock:

$$\frac{K_x(t)}{K(t)} + \frac{K_y(t)}{K(t)} \equiv v_x + v_y \equiv 1. \quad (12)$$

Denoting that $k_i = \frac{K_i}{L_i}$, $i = x, y$ we write the following:

$$k \equiv \frac{K}{L} \equiv l_x k_x + l_y k_y \equiv k_x + (k_y - k_x) l_y. \quad (13)$$

Hence:

$$l_x \equiv \frac{k - k_y}{k_x - k_y}, \text{ and } l_y = 1 - l_x. \quad (14)$$

Capital allocation across the two sectors is determined as:

$$v_x \equiv \frac{l_x k_x}{k}, \text{ and } v_y \equiv \frac{l_y k_y}{k}. \quad (15)$$

The last result implies that the equilibrium values of k_x and k_y determine the allocation of factors in the two sectors. Given the per worker stock of capital in each sector, we can express output in each sector in per worker terms. That is, output per worker will be given by:

$$x = A k_x^\alpha, \quad (16)$$

and:

$$y = B k_y^\beta. \quad (17)$$

Foreign trade

We assume that all mining output is exported and foreign currency earnings are used to import manufactured consumer good, which is a perfect substitute for domestically produced manufactured good X . For simplicity we assume that trade is always balanced, and the real exchange is equal to unity in terms of domestically manufactured good, X .

This implies that:

$$C_x^I(t) = PD_Y(t), \quad (18)$$

where $C_x^I(t)$ is imported manufactured good and $D_Y(t)$ is foreign demand for mining output, Y .

2.2. The demand side

The demand for goods consists of domestic demand from households for manufactured goods and foreign demand for mining output.

Households

Labour force, $L(t) = L$, is assumed to be static in order to abstract from population growth issues. If total consumption of good X is given as a sum of both the domestically produced and its perfect substitute imported from overseas, $C(t) = C_x^H(t) + C_x^I(t)$ at time t , then consumption per adult person is given by $c(t) \equiv C(t) / L(t)$. Each household's wishes to maximize overall utility, U , given by:

$$U = \int_0^{\infty} u[c(t)] e^{-\rho t} dt, \quad (19)$$

subject to its budget constraints:

$$\dot{k} = (rk + w) - c + h, \quad (20)$$

$$k(0) = k_0 \quad (21)$$

where \dot{k} and $k \equiv K/L$ stand for a change and level of physical capital stock per worker respectively, ρ is the time preference, and h is the lump-sum transfers provided by government.

Let us assume a specific functional form for the instantaneous utility as $u(c) = \log(c)$ and find the first-order conditions of the household's problem.

To solve this problem we set up the following Hamiltonian:

$$H = \log(c)e^{-(\rho-n)t} + \lambda[(rk + w) - c + h]. \quad (22)$$

The first-order conditions are:

$$\frac{\partial H}{\partial c} = 0: \lambda = \frac{e^{-\rho t}}{c}, \quad (23)$$

$$\dot{\lambda} = -\frac{\partial H}{\partial k}: \dot{\lambda} = -(r - \rho)\lambda. \quad (24)$$

To rule out non-optimal solutions the following transversality condition is assumed to be satisfied:

$$\lim_{t \rightarrow \infty} [\lambda(t)k(t)] = 0. \quad (25)$$

Foreign demand

Foreign demand for the mining sector output is assumed to have the following functional form:

$$D_Y = \frac{S^\theta}{\phi P}, \quad (26)$$

where S stands for the demand shock parameter that represents a positive effect on the demand for mining sector output, so that $\partial D_y / \partial S > 0$. In addition, it is assumed that demand declines with higher prices, hence, $\partial D_y / \partial P < 0$.

Since the home country does not consume mining output, its relative price, P , is exogenous to this economy. Moreover, from (26) one can find that $\partial(PD_y) / \partial S > 0$, which implies that any shift in the foreign demand for resources results in a nominal increase in the output of the mining sector. It is sensible to assume that this increase in nominal demand is partly caused by the increase in price level, P .

The government

The government collects revenue (in per worker terms), R , by taxing the profits of mining and manufacturing firms. The collected revenue is spent on lump-sum transfers, T , and on provision of productive public goods, g .

$$g = \gamma R, \text{ and} \tag{27}$$

$$T = (1 - \gamma)R, \tag{28}$$

where γ is the share of spending on production of public good. Thus, the government faces the following budget constraint expressed in per worker terms:

$$R = (\tau_x + \tau_y)(x + Py). \tag{29}$$

Given the burden of the public sector on the private sector, we can also state the overall constraint for the economy in per worker terms as follows:

$$\dot{k} = \left[(1 - \gamma\tau_x)x + (1 - \gamma\tau_y)Py \right] - c. \quad (30)$$

2.3. Macroeconomic Equilibrium

2.3.1. Definition

Equilibrium in this economy is defined by a sequence of prices $\{P(t), r(t), w(t)\}_{t=0}^{\infty}$, real allocations $\{C(t), K(t), L(t), l_x, v_x, l_y, v_y, x, y\}_{t=0}^{\infty}$, and policy variables $\{\tau_x, \tau_y, \gamma\}$ such that:

- i. the optimization problems of households and firms; and
- ii. the budget constraints of households and the government are satisfied.
- iii. labour market, goods market, and capital market clear; and
- iv. the aggregate resource constraint (30) is satisfied.

2.3.2. Results

The optimality conditions are derived by solving the first order conditions of the consumers and producers:

$$u_c = \lambda, \quad (31)$$

$$w = w_x = w_y, \quad (32)$$

$$r = r_y = r_x, \quad (33)$$

$$Y = D_Y = \frac{S^\theta}{\phi P}. \quad (34)$$

Based on these conditions we need to find: l_x, l_y, k_x, k_y in terms of $k(t)$ and $\lambda(t)$.

Due to free factor mobility, we obtain the MRS condition:

$$\omega = \frac{w}{r} = \frac{f_i(k_i)}{f_i'(k_i)} - k_i. \quad (35)$$

Then we can find that:

$$k_x = \frac{\alpha\omega}{1-\alpha}, \quad (36)$$

$$k_y = \frac{\beta\omega}{1-\beta}. \quad (37)$$

From $w = w_x = w_y$, we can write:

$$A(1-\tau_x)(1-\alpha)k_x^\alpha = PB(1-\tau_y)(1-\beta)k_y^\beta. \quad (38)$$

By substituting from (36) and (37) we solve for ω , k_x , k_y , l_x and l_y .

$$\omega = \left[\frac{A(1-\alpha)^{1-\alpha} \alpha^\alpha}{PB(1-\beta)^{1-\beta} \beta^\beta} \eta \right]^{\frac{1}{\beta-\alpha}}, \quad (39)$$

where $\eta = \frac{(1-\tau_x)}{(1-\tau_y)}$.

$$k_x = \frac{\alpha}{1-\alpha} \left[\frac{A(1-\alpha)^{1-\alpha} \alpha^\alpha}{PB(1-\beta)^{1-\beta} \beta^\beta} \eta \right]^{\frac{1}{\beta-\alpha}}, \quad (40)$$

$$k_y = \frac{\beta}{1-\beta} \left[\frac{A(1-\alpha)^{1-\alpha} \alpha^\alpha}{PB(1-\beta)^{1-\beta} \beta^\beta} \eta \right]^{\frac{1}{\beta-\alpha}}, \quad (41)$$

$$l_y \equiv \frac{k - k_y}{k_y - k_x} = \frac{(1-\alpha)(1-\beta)}{\beta(1-\alpha) - \alpha(1-\beta)} \left[\frac{PB(1-\beta)^{1-\beta} \beta^\beta}{\eta A(1-\alpha)^{1-\alpha} \alpha^\alpha} \right]^{\frac{1}{\beta-\alpha}} k - \frac{(1-\alpha)\beta}{\beta(1-\alpha) - \alpha(1-\beta)}, \quad (42)$$

$$l_x \equiv 1 + \frac{(1-\alpha)\beta}{\beta(1-\alpha) - \alpha(1-\beta)} - \frac{(1-\alpha)(1-\beta)}{\beta(1-\alpha) - \alpha(1-\beta)} \left[\frac{PB(1-\beta)^{1-\beta} \beta^\beta}{\eta A(1-\alpha)^{1-\alpha} \alpha^\alpha} \right]^{\frac{1}{\beta-\alpha}} k. \quad (43)$$

2.3.3. Short-run equilibrium

Examining equation (34), we can see that in the short run (as defined by Brock, 1996) for given k and λ , a mining boom caused by a shift in foreign demand leads to an increase in the price of Y . Moreover, in the context of a small economy, this price is exogenously determined. Therefore, we can analyse the impact of shifts in external demand for mining output in terms of an increase in the price of the mining good.

Proposition 1. *A mining boom leads to a shift towards more labour-intensive production.*

Proof. Based on expressions given by (40)-(43) we can confirm that, in the short run,

$$\frac{\partial k_x}{\partial P} < 0 \text{ and } \frac{\partial k_y}{\partial P} < 0, \text{ hold. This implies that production becomes less capital intensive,}$$

hence, more labour intensive.

Equations (40)-(43) illustrate the effect of a price increase in the mining sector on allocation of capital and labour in the economy. A mining boom leads to a lower capital-labour ratio and a lower share of total labour in the manufacturing sector (good X). On the other hand, the mining sector gets a higher allocation of labour due to the following result:

$$\frac{\partial l_x}{\partial P} < 0, \quad \frac{\partial l_y}{\partial P} > 0. \quad (44)$$

Lower capital-labour ratio in both sectors is also consistent with an increase in relative return to capital, $\frac{1}{\omega}$, as:

$$\frac{\partial \omega}{\partial P} < 0. \quad (45)$$

This result is the well-known *Stolper-Samuelson theorem* which states that if the price of capital-intensive good rises, the rental price of capital rises. Further, the increase in rental price is greater relative to the increase in the output price.

It can be verified that the relative price of mining good satisfies:

$$P = \frac{f'_x}{f'_y} = \frac{MPL_x}{MPL_y} = \frac{(1-\alpha)A k_x^\alpha}{(1-\beta)B k_y^\beta}. \quad (46)$$

Results given by Proposition 1 and the production technology employed by the manufacturing sector given by (1) imply that:

$$\frac{\partial X}{\partial P} < 0. \quad (47)$$

This result is summarised as the following lemma.

Lemma 1. *In the short run, a mining boom leads to a contraction in manufacturing output.*

This effect of a mining boom poses a problem of a two-speed economy. The main policy implication of such a condition is that a monetary policy would prove to be less effective since it cannot differentiate between the growing and contracting sectors. Further, as seen from equation (45), relative return to capital, $\frac{1}{\omega}$, increases during the boom. Thus, using

contractionary monetary policy to counteract the effects of a resource boom would exacerbate this distortion by suppressing wages relative to the interest rate.

Thus, we can trace the effect of a mining boom on employment and wages based on these short-run results. Using the wage rate equations we can write:

$$w = A(1 - \tau_x)(1 - \alpha)k_x^\alpha \quad (48)$$

It is obvious that an increase in P will lead to a decrease in the wage rate, w , because

$\frac{\partial k_x}{\partial P} < 0$. However, before attaining equilibrium where wage rates are equalized as,

$$w_x \equiv A(1 - \tau_x)(1 - \alpha)k_x^\alpha = w_y \equiv PB(1 - \tau_y)(1 - \beta)k_y^\beta,$$

there will be a transition path during which the demand shock will lift the wage rate in the mining sector, so that $w_x < w_y$. This disequilibrium then drives the reallocation of production factors from the non-mining sector to the mining sector. In any case, we see that the initial effect of a mining boom on prices is inflationary driven by the relative growth of wage rate in the mining sector. Moreover, the wage growth stemming from a mining boom implies that labour demand in the manufacturing sector falls to accommodate both, increasing wages and falling output, demonstrated by (48) and (47) respectively.

$$L_x w = (1 - \alpha)(1 - \tau_x)X \quad (49)$$

In the manufacturing sector, a decrease in output and increasing wage rates lead to a fall in employment, L_x .

2.3.4. Steady-state equilibrium

Based on (24) and (30), the dynamics of the economy are described by the following system of differential equations:

$$\dot{\lambda} = \lambda [\rho - (1 - \tau_x)x_k] \quad (50)$$

$$\dot{k} = [(1 - \gamma\tau_x)x + (1 - \gamma\tau_y)Py] - c \quad (51)$$

To rule out suboptimal solutions, it is also assumed that the following transversality condition holds:

$$\lim_{t \rightarrow \infty} \{k(t)e^{(r-\rho)t}\} = 0. \quad (52)$$

We need to determine the Jacobian of this system:

$$J = \begin{bmatrix} (1 - \gamma\tau_x)\frac{\partial x}{\partial k} + P(1 - \gamma\tau_y)\frac{\partial y}{\partial k} + \frac{\partial P}{\partial k}(1 - \gamma\tau_x)y - \frac{\partial c}{\partial k}; & y\frac{\partial P}{\partial \lambda} - \frac{\partial c}{\partial \lambda} \\ -\lambda(1 - \tau^x)x_{kk}; & \rho - (1 - \tau^x)x_k \end{bmatrix} \quad (53)$$

It can be verified that the determinant of the Jacobian is negative, $|J| < 0$; thus, the steady-state equilibrium is saddle-point stable. The proof is given in the Appendix.

By assuming $\dot{\lambda} = 0$ and $\dot{k} = 0$ and solving (50), one can find steady state value of $\bar{\lambda}$ and \bar{k} .

From (42) and (43), it is clear that in a steady state $\bar{l}_i = \text{const.}$ for $i = x, y$. This implies, based on (13), that $\bar{k}_i = \text{const.}$ for $i = x, y$, and based on (15) that $\bar{v}_i = \text{const.}$ for $i = x, y$. Then, from (50) we can solve for the steady-state capital per worker:

$$\bar{k} = \left(\frac{\zeta - (1 - \gamma\tau_x)A \left(\frac{\bar{v}_x}{\bar{l}_x} \right)^\alpha}{(1 - \gamma\tau_y)BP \left(\frac{\bar{v}_y}{\bar{l}_y} \right)^\beta} \right)^{\frac{1}{\beta - \alpha}}, \quad (54)$$

where $\zeta \equiv \frac{\bar{c}}{\bar{k}^\alpha}$. It is easy to see that:

$$\bar{\lambda} = \frac{1}{\bar{c}}. \quad (55)$$

Based on the above expression (54), we can show the effect of relative price increase on the steady state capital stock. This implication is stated as the following lemma.

Lemma 2. *A mining boom results in a reduction of steady state capital stock per worker.*

Proof. It can be verified that $\frac{\partial \bar{k}}{\partial P} < 0$.

This outcome is driven by the fact that an increase in relative returns to capital caused by a mining boom results in a shift towards labour-intensive production. This implies that the stock of capital per worker in the steady state is reduced. This finding is in line with the result by Van Wijnbergen (1985), who has shown that if the non-traded sector is more labour intensive than the traded sector, a resource boom results in decline of capital stock. Analogously, Chao et al. (2006) show that a tourism boom can lead to lower capital accumulation.

Next, we need to analyse the effect of a mining boom on welfare in the long run, which depends on the long-run (steady-state) consumption level. Hence, based on differential equation (51), we analyse how steady-state consumption $\bar{c} = (1 - \gamma\tau_x)\bar{x} + (1 - \gamma\tau_y)P\bar{y}$ is affected by a mining boom. It can be verified that $\frac{\partial P}{\partial S} > 0$, which implies that $\frac{\partial \bar{c}}{\partial P} \Rightarrow \frac{\partial \bar{c}}{\partial S} < 0$.

Then the change in welfare is determined by:

$$\frac{\partial \bar{c}}{\partial P} = (1 - \gamma\tau_x)\frac{\partial \bar{x}}{\partial P} + (1 - \gamma\tau_y)\left[\bar{y} + P\frac{\partial \bar{y}}{\partial P}\right]. \quad (56)$$

Clearly, if the effect of de-industrialisation (that is, the impact of a contraction in the manufacturing sector) is stronger than the positive terms of trade effect on the mining sector, the overall effect on long-run consumption per capita becomes negative. This discussion is stated as the following proposition.

Proposition 2. *A mining boom may result in a long-run welfare loss.*

This result can be viewed as a version of the so-called “immiserizing growth” coined by Bhagwati (1958). For example, Chao et al. (2006), and Hazari and Nowak (2003) demonstrate a possibility of immiserization in the home country due to a boom in tourism. Along this line, Beladi and Marjit (1992) present a model of an economy with an enclave, demonstrating that if a protected import-competing sector exists and the rents to foreign capital are repatriated, immiserizing growth occurs when the enclave expands. Saha and Gilbert (2004) find that a country can avoid immiserization from a two-speed economy only

if labour in the economy is immobile. In general, a two-speed-economy appears to be harmful for the welfare of the economy. This is corroborated by Basu and Hazari (2008), who find that an increase in urban capital caused by a worsening of the relative price of rural non-traded goods to urban non-traded goods necessarily immiserizes the rural region and thereby increases inequality among regions.

The negative impact of a mining boom comes through its contribution to a worsening of income distribution. We can identify this effect by considering the increase in long-run returns to capital relative to the wage rate, as $\frac{\partial \bar{\omega}}{\partial P} < 0$. This result implies that during a mining boom, those who generate most of their income in the form of labour income will have a relatively lower income than those who derive most of their income from rental returns to capital.

3. Policy Implications

The findings from the short-run analysis indicate that a mining boom leads to a reallocation of labour from manufacturing to mining and to an increase in wages during the transition to a new equilibrium. We assume no labour market frictions in this model. In reality, frictions and rigidities in the labour market means that some workers who lose their jobs in sector X cannot shift to sector Y . This leads to an increase in the natural rate of unemployment, and the mining sector will face labour shortages. Clearly, with increased impediments to labour reallocation, labour shortages in the mining sector become more acute and result in more upward pressure on wages. The resulting increase in wages would cause a further

decline in the labour demand in the manufacturing sector. Thus, especially in the short run, a mining boom leads to a problem of labour allocation across the two sectors and puts additional pressure on the non-mining sector of the economy.

Immigration is one of the policy measures that can help tackle this challenge of labour allocation in the short run. As a transitional measure, an increase in immigration, particularly migration targeted at meeting the additional demand in mining, can soften the impact of a mining boom on the labour market conditions. If all of the added labour demand generated in mining sector, $\Delta L_y = (1 - \beta)(1 - \tau_Y)\Delta(PY)$, is covered by immigration and labour movements from sector X , there will be no wage increase. In reality, of course it is not possible to exactly match the changes in labour demand by changes in immigration. However, the right policy response in the short run is to increase, rather than decrease, the migration intake. Overall, an appropriate mix of increased migration and improved transition of labour across sectors will work to relieve the upward pressure on wages caused by a mining boom. It is important to note, however, that while immigration would help mitigate the short run adverse effect on wages, it cannot be a long term solution. The reason is that a mining boom lowers wages relative to the return on capital in the long run. Therefore, added increases in labour supply would further worsen the gap between labour income earners and capital owners.

Another way to moderate the impact of the mining boom on wages as well as on the steady state welfare is through taxation of the mining sector. Increasing the tax rate on profits in

the mining sector will decrease the real returns to capital in the mining sector and dampen the wage increase. Revenues generated by taxing sector Y at a higher rate ($\tau_y > \tau_x$) can be used to pay social benefits or to fund training for those who lose jobs in sector X, and to improve provision of public goods (infrastructure) that increase the productivity in sector X. By considering the respective comparative statics, we can verify that the distortive effect of a mining boom can indeed be counterweighed by increasing the after-tax profit ratio

$\eta = \left(\frac{(1-\tau_x)}{(1-\tau_y)} \right)$. That is, it can be shown that $\frac{\partial \bar{k}_x}{\partial \eta} > 0$, $\frac{\partial \bar{k}_y}{\partial \eta} > 0$, $\frac{\partial \bar{l}_x}{\partial \eta} > 0$, and $\frac{\partial \bar{l}_y}{\partial \eta} < 0$. This

effect of taxation is also reinforced by the positive externality of public spending, g , on productivity in the manufacturing sector, $A(g)$, as $A'(g) > 0$. Generally higher the productivity enhancement provided by the public sector to the non-resource sectors, smaller would be the tax surcharge imposed on mining.

An important point here is that the taxation policy in this context should be aimed towards correction of distortions, rather than the fiscal needs of the government. Over-taxing the mining sector to solve fiscal difficulties can prove to be welfare-deteriorating in the long run, as a mining boom has a positive effect through domestic spending of the profits earned by the mining companies. We summarize this discussion as the following proposition.

Proposition 3. *Imposition of tax rates on the profits of mining sector firms, which is higher than for the tax rate for the rest of the economy, offsets the de-industrialisation effect caused by a mining boom.*

The results also illustrate that a mining boom contributes to a worsening of income distribution. Hence, higher taxation of the mining sector is also justified on the grounds of equity; government may re-distribute a part of the tax receipts to the households severely affected by the distortions caused by a mining boom. The role of fiscal policy, both through taxation and redistribution via transfer payments and public goods provision, is particularly important given that the monetary policy response to a mining boom is likely to be a rise in interest rates. Higher interest rates actually aggravate the adverse effect of a resource boom on the non-resource sectors, as the results indicate that they are already facing higher than usual returns to capital.

Higher taxation of the mining sector should not be seen as an easy way to collect taxes for government needs and may not be justified solely on the grounds of super-profits. However, our analysis shows that differential taxation is one of the ways of ensuring that the overall effect of the boom is welfare-improving by correcting the distortions created by a mining boom in terms of the pressure on factor prices, output and productivity in non-resource sectors, and income distribution in the economy.

4. Conclusion

Using a dynamic macroeconomic model we have demonstrated the effect of a resource boom on allocations in the economy. Tracing the effects of a boom in the resource sector on the rest of the economy, the model highlights the distributional impacts. Positive demand shock in the resource sector leads to a contraction of the manufacturing sector and, hence,

can lead to a long run welfare loss if such de-industrialisation outweighs the positive terms of the trade effect. Importantly, returns to capital increase at the cost of returns to labour, creating challenges in the form of income distribution within the economy.

These effects of a resource boom pose unique challenges for policymakers. This paper has investigated the appropriate mix of policy options which are the subject of current debate in Australia, and has demonstrated that monetary policy response would exacerbate the adverse distributional impacts between labour and capital. Similarly, while higher immigration would ease the short run labour allocation problem, it would increase the gap between labour and capital incomes in the long run. Higher taxation of the mining sector, on the other hand, would moderate the effect on wages as well as on the steady state welfare. The results of this paper demonstrate that such a tax regime can be efficient and equitable, particularly if the increased tax revenue is appropriately used to compensate labour income and to increase provision of public goods for the manufacturing sector.

Appendix: Stability of steady state equilibrium

Let us write

$$J = \begin{bmatrix} (1 - \gamma\tau_x) \frac{\partial x}{\partial k} + P(1 - \gamma\tau_y) \frac{\partial y}{\partial k} + \frac{\partial P}{\partial k} (1 - \gamma\tau_x) y - \frac{\partial c}{\partial k}; & y \frac{\partial P}{\partial \lambda} - \frac{\partial c}{\partial \lambda} \\ -\lambda(1 - \tau^\pi) x_{kk}; & \rho - (1 - \tau^\pi) x_k \end{bmatrix},$$

as $J = \begin{bmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{bmatrix}$. Hence we need to determine $\text{sign}[\det(J)] = \text{sign}[m_{11}m_{22} - m_{12}m_{21}]$.

As $\frac{\partial x}{\partial k} > 0$, $\frac{\partial y}{\partial k} > 0$, and $\frac{\partial c}{\partial k} < 0$, and only $\frac{\partial P}{\partial k} < 0$ in equilibrium, the magnitude of which

assumes that downward stickiness of prices should be less than the magnitude of change in real output; hence $m_{11} > 0$. Clearly, when the system is out of steady state, $m_{22} < 0$.

Apparently, $m_{21} > 0$, as $x_{kk} < 0$ by definition. Also $\frac{\partial P}{\partial \lambda} > 0$, and $\frac{\partial c}{\partial \lambda} < 0$, and hence, $m_{12} > 0$.

This implies that $\text{sign}[\det(J)] = \text{sign}[m_{11}m_{22} - m_{12}m_{21}] < 0$.

References

Anderson, K. 1998, 'Are Resource Abundant Economies Disadvantaged?', *The Australian Journal of Agricultural and Resource Economics*, 42, pp. 1-23.

Auty, R. 2010, 'The Political Economy of Resource-driven Growth', *European Economic Review*, 45, pp. 839-846.

Basu, B. & Hazari, B.R. 2008, 'Regional Inequality and Immiserization', *Journal of Economic Policy Reform*, 11, pp. 201–213.

Battellino, R. 2010, 'Mining Booms and the Australian Economy', *Bulletin*, March, pp. 63-70.

Beladi, H. & Marjit, S. 1992, 'Foreign Capital and Protectionism', *Canadian Journal of Economics*, 25, pp. 233-238.

Bhagwati, J. 1958, 'Immiserizing Growth: A Geometrical Note', *Review of Economic Studies*, 25, pp. 201-205.

Brock, P. L. 1996, 'International Transfers, the Relative Price of Non-traded Goods, and the Current Account', *Canadian Journal of Economics*, 29, pp. 161–180.

Cassing, J. H. & Warr, P.G. 1985, 'The Distributional Impact of a Resource Boom', *Journal of International Economics*, 18, pp. 301-319.

Chang, Juin-Jen, Lu, Lee-Jung & Hu, Shin-Wen 2011, 'Congestion Externalities of Tourism, Dutch Disease and Optimal Taxation: Macroeconomic Implications', *Economic Record*, 87, pp. 90–108.

Chao, C.C., Hazari, B.R., Laffargue, J.P., Sgro, P.M. & Yu, D.S.H. 2006, 'Tourism, Dutch Disease and Welfare in an Open Dynamic Economy', *The Japanese Economic Review*, 57, pp. 501–15.

Corden, W.M. & Neary, J.P. 1982, 'Booming Sector and De-Industrialisation in a Small Open Economy', *Economic Journal*, 92, pp. 825–48.

Corden, W.M. 1984, 'Booming Sector and Dutch Disease Economics: Survey and Consolidation', *Oxford Economic Papers*, 36, pp. 359–80.

Ergas, H., Harrison, M. & Pincus, J. 2010, 'Some Economics of Mining Taxation', *Economic Papers*, 29, pp. 369-383.

Frankel, J., 2010, "The Natural Resource Curse: A Survey", NBER Working paper 15836

Freebairn, J. & Quiggin, J. 2010, 'Special Taxation of the Mining Industry', *Economic Papers*, 29, pp. 384-396.

Fum, R. M. & Holder, R. 2010, 'Natural Resources and Income Inequality: the Role of Ethnic Divisions', *Economic Letters*, 107, pp. 360-363.

Gregory, R. 1976, 'Some Implications of the Growth of the Mineral Sector', *Australian Journal of Agricultural Economics*, 20, pp. 71-91.

Gylfason, T., Herbertson, T. T. & Zoega, G. 1999, 'A Mixed Blessing: Natural Resources and Economic Growth', *Macroeconomic Dynamics*, 3, pp. 972-991.

Hazari, B. R. & Nowak, J.J 2003, 'Tourism, Taxes and Immiserization: A Trade Theoretic Analysis', *Pacific Economic Review*, 8, pp. 279-287.

Kuralbaeva, K. & Vines, D. 2008, 'Shocks to Terms of Trade and Risk-premium in an Intertemporal Model: the Dutch Disease and a Dutch Party', *Open Economies Review*, 19, pp. 277-303.

Matsen, E. & Torvik, R. 2005, 'Optimal Dutch Disease', *Journal of Development Economics*, 78, pp. 494-515.

Ploeg, F. van der 2011, 'Natural Resources: Curse or Blessing', *Journal of Economic Literature*, 49, pp. 366-420.

RBA 2011, Australian Economy and Financial Markets, Chart Pack, Available: <http://www.rba.gov.au/chart-pack/> , accessed 2011, July 1st

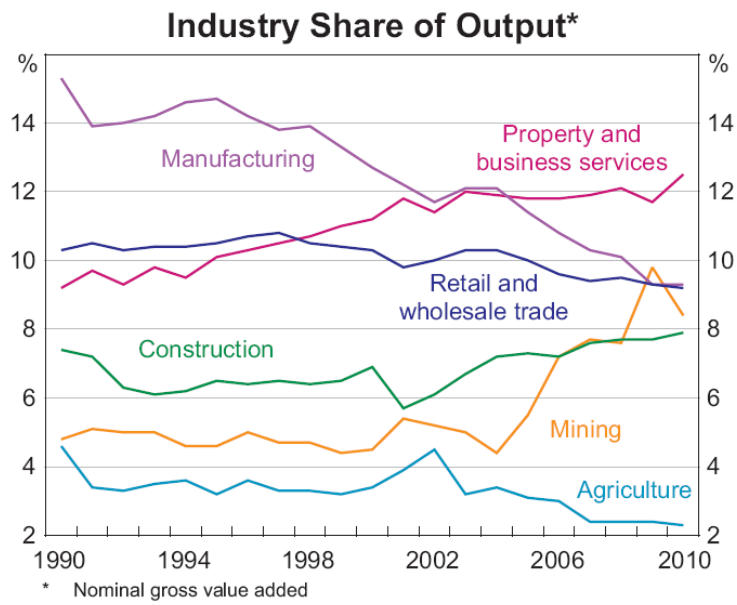
Sachs, J. & Warner, A. 2001, 'Natural Resources and Economic Development: The Curse of Natural Resources', *European Economic Review*, 45, pp. 827-838.

Saha, N. & Gilbert, J. 2004, 'Immiserizing Growth in a Developing Economy Export Enclave', *International Journal of Business and Economics*, 3, pp. 217-224.

Stevens, G. 2011, 'The Resources Boom', *Bulletin*, March, pp. 67-72.

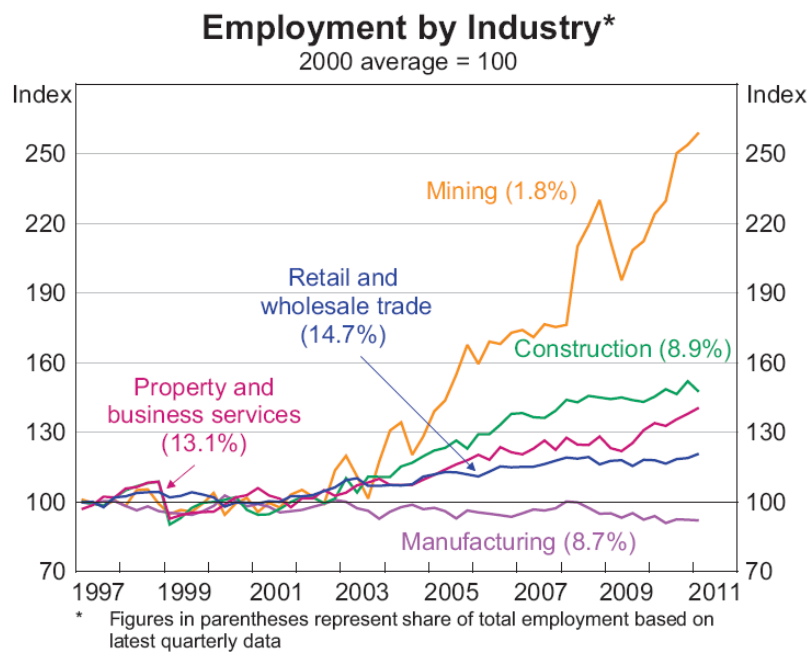
Van Wijnbergen, S. 1985, 'Optimal Capital Accumulation and the Allocation of Investment between Traded and Nontraded Sectors in Oil-Producing Countries', *The Scandinavian Journal of Economics*, 87, pp. 89-101.

Figure 1: Output



Source: RBA (2011)

Figure 2: Employment



Source: RBA (2011)